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● *Clinical Note*

INTRACAVITARY CONTRAST-ENHANCED ULTRASOUND IN THE MANAGEMENT OF POST-SURGICAL GASTROINTESTINAL FISTULAS

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Abstract—The goal of this study was to investigate intracavitary contrast-enhanced ultrasound (IC-CEUS) measures in the management of post-surgical gastrointestinal (GI) fistula throughout detection, treatment and follow-up. From June 2010 to August 2016, patients who were administered ultrasound contrast agent (UCA) *via* a drainage tube for IC-CEUS were enrolled and retrospectively analyzed. They were suspected of having GI anastomotic fistulas or had been found to have fluid collections with ultrasound that were accompanied by abdominal pain or fever after surgical procedures. Forty-two patients met the inclusion criteria and were enrolled into this study. Twenty-two were confirmed to have GI fistulas confirmed by standard references. None were detected by conventional ultrasound. Although IC-CEUS successfully detected GI fistulas in 16 patients, it missed GI fistulas in 6 patients. One patient was misdiagnosed with a GI fistula. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of the diagnosis of GI fistulas by IC-CEUS were 72.7% (16/22), 95.0% (19/20), 94.1% (16/17), 76.0% (19/25) and 83.3% (35/42), respectively. Twenty peritoneal fluid collections in 14 patients were related to fistulas by IC-CEUS based on the distribution of ultrasound contrast agents. Additional drainage was performed in 14 fistula-related fluid collections. Eight GI fistulas were judged to be cured after IC-CEUS re-evaluation, and the drainage tubes were removed from these patients. In conclusion, IC-CEUS can greatly improve the ability to diagnose post-surgical GI fistulas and may also play an important role in interventional treatment and follow-up. (E-mail: zhengrq@mail.sysu.edu.cn) © 2017 World Federation for Ultrasound in Medicine & Biology. All rights reserved.

Key Words: **Ultrasound, Gastrointestinal fistula, Contrast-enhanced ultrasound, Management.**

INTRODUCTION

Gastrointestinal (GI) fistula is a serious complication after surgical procedures and has a mortality varying from 15% to 37% (Campos et al. 1996; Girard et al. 2014; Pickhardt et al. 2002). There are a series of potential fistulous sequelae including malnutrition, pain, fluid collection, localized abscess, sepsis and even death. These sequelae may lead to prolonged hospital stays and increased hospital expenditures and inflict a psychological burden on patients (González-Pinto and González 2001).

Imaging modalities play an important role in the management of fistulas (Pickhardt et al. 2002). In the management of GI fistulas, the detection of these abnormal communications without delay is the first step. With the development of interventional treatment, some patients with GI fistulas can be treated by imaging-guided percutaneous drainage (Hwang and Schwartz 2000; Müller-Wille et al. 2011). After interventional treatment, the follow-up of fluid collections and fistulas is very important to the evaluation of outcomes (Hwang and Schwartz 2000). The X-ray fistulogram is a simple but crucial imaging modality in the diagnosis of GI fistulas. It can directly reveal the abnormal communications. However, it is not suitable for critical care patients after surgery. It is also inadequate in imaging-guided percutaneous drainage because of its poor soft tissue resolution. Cross-sectional imaging techniques, particularly computed tomography (CT), may provide further information on GI fistulas, including the presence of fluid collections. It can also serve as imaging guidance for interventional treatment. However, it is not sufficiently sensitive to reveal abnormal communications directly. It is also unsuitable for

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bedside emergency examinations and repeated follow-up because of its inconvenience, high price and radiation exposure (Evenson and Fischer 2006; González-Pinto and González 2001; Pickhardt et al. 2002).

Conventional ultrasound (CUS) is usually employed to explore and follow up abscesses or fluid collections in patients with GI fistulas. It is the most common imaging guidance tool for interventional treatment. Bedside CUS examination is especially suitable for some critical care patients. However, because of the many interfering factors after surgery, CUS is not the preferred imaging modality for the detection of GI fistulas and collection of further information on treatment and outcomes (González-Pinto and González 2001; Lee and Stein 2010; Maconi et al. 2006; Pickhardt et al. 2002; Thomas 1996).

Intracavitary contrast-enhanced ultrasound (IC-CEUS), in which ultrasound contrast agent (UCA) is administered *via* a drainage tube or natural orifice, is becoming more common (Heinzmann et al. 2012; Piscaglia et al. 2012; Xu et al. 2012; Zheng et al. 2010). Recently, there have been case reports regarding the detection of fistulas using IC-CEUS (Chen et al. 2016; Mao et al. 2010; Pei et al. 2011). Like X-ray fistulography, IC-CEUS is able to reveal the abnormal communication directly and provide further information about the fistulas. However, reports on the application of IC-CEUS for the complete management of post-surgical GI fistulas are lacking. In the study described here, we investigated IC-CEUS measures (sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy) in the management of post-surgical GI fistulas throughout detection, treatment and follow-up.

METHODS

Patients

From June 2010 to August 2016, patients who (i) were suspected of having a GI anastomotic fistula after a surgical procedure and (2) had a fluid collection with abdominal pain or fever after a GI surgical procedure were introduced to IC-CEUS examination and enrolled into this study. The standard reference included X-ray fistulogram, surgical exploration and typical clinical signs such as unusual effluents with gastrointestinal contents and significantly increased amylase/lipase from peritoneal drainage fluids (González-Pinto and González 2001). Positive cases were confirmed as GI anastomotic fistulas when they met one of the standard references. Negative cases were confirmed by X-ray fistulography, without typical clinical signs, and were followed up for at least 1 mo.

This study was approved by the institutional review board of our hospital. Written informed consent for IC-CEUS examination was obtained from each patient.

Ultrasound equipment and contrast agents

Ultrasound machines associated with respective contrast-specific imaging modes were used in this study, including MyLab Twice (Esaote Biomedica, Genoa, Italy) with a CA541 transducer (frequency: 1–8 MHz), LOGIC E9 (GE Healthcare, Milwaukee, WI, USA) with a C1-5-D transducer (frequency: 1–6 MHz) and Sequoia 512 (Siemens Medical Solutions, Mountain View, CA) with a 4 C1 transducer (frequency: 1–4 MHz). A low mechanical index (MI) (≤0.20) was used for IC-CEUS.

The sulfur hexafluoride-filled microbubble UCA SonoVue (Bracco, Milan, Italy) was used for the IC-CEUS study. SonoVue is the only UCA licensed in China and has an excellent safety profile in high-contrast imaging (Piscaglia et al. 2012). On the basis of our previous experiences (Xu et al. 2012), the SonoVue was diluted to 1:100–1:300 by mixing 0.1 mL SonoVue with 10–30 mL 0.9% saline solution for intracavitary administration. Dosages ranged from 30 to 50 mL. Administration of the diluted UCAs could be repeated to obtain optimal imaging quality and sufficient diagnostic information. The total dosage was generally less than 100 mL in each patient.

Ultrasound examination procedure

Four sonologists performed CUS and IC-CEUS (E.J.X., K.L., Z.Z.S., and R.Q.Z). All were senior sonologists with at least 8 y of experience in CUS and IC-CEUS examinations.

Initially, all patients underwent general CUS scanning per clinical requirements. The whole abdomen should be scanned by CUS. Organs, such as the liver, gallbladder, spleen and pancreas, were scanned first. Then the whole abdomen, including the perihepatic space, peripancreatic space, perigastric space, perisplenic space, intestinal space and pelvic cavity, were explored step by step. Fluid collections (including abscesses) and sites of drainage tubes were the focus of observations. If the orifice of a GI fistula was detected by CUS, the GI fistula could be diagnosed by CUS. Then, the diluted UCA were administered *via* the peritoneal drainage tubes that had been placed in patients during surgery. If UCA was detected in the GI tract, the GI fistula could be diagnosed by IC-CEUS. In IC-CEUS, the dual display mode or mixed display mode (CUS and CEUS images could be displayed side by side or overlapping) was used for observing the anatomic structures simultaneously. Fluid collections (including abscesses) in the abdominal cavity were explored and evaluated. When distribution of UCA into the fluid collection was observed with the detection of a GI fistula, the fluid collection was considered to be related to the GI fistula. If required, ultrasound-guided percutaneous drainage was carried out. All fistulas were followed up with CUS and IC-CEUS as needed. Treatment of GI fistulas was recorded.